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ABSTRACT

Intended for elementary school language arts teachers, this paper outlines some recent work in the area of cognitive functioning and shows how this highlights the necessity for great care in fostering a child's language competence at two different stages: very early childhood and early to middle primary school. Following an introduction, the paper reviews literature on the development of intellectual functioning. Next, research on language development and logical functioning is examined. An appendix contains an example of a response model (SOLO taxonomy) for evaluating the quality of creative writing. Summaries or abstracts (listed in the document as "annexes") are included for the following references: "Evaluating the Quality of Learning: the SOLO Taxonomy," by J. B. Biggs; "The Underlying Mechanism of Intellectual Development," by R. Case; "Children's Minds," by M. Donaldson; "A Theory of Cognitive Development: The Control and Construction of Hierarchies of Skills," by K. W. Fischer; and "Phenomenography--Describing Conceptions of the World around Us," by F. Marton. (HTH)

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LANGUAGE DEVELOPMENT AND INTELLECTUAL FUNCTIONING

Kevin F. Collis

*Occasional Papers
No. 10*

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PREFACE

This series of Occasional Papers is published by the Asian Centre of Educational Innovation for Development (ACEID), Unesco Regional Office for Education in Asia and the Pacific, as part of its effort to build up an information base in support of the Asian Programme of Educational Innovation for Development (APEID). Papers received from eminent educationists are reproduced for distribution so that their new ideas, approaches, ways of looking at education may be made widely known as a source of stimulation for further reflection and discussion.

ABOUT THE AUTHOR

The author of this paper, Professor Kevin F. Collis, is Professor of Education and Head of the Department of Educational Studies, University of Tasmania, Australia. He was previously Associate Professor of Education and Head of the Department of Education at the University of Newcastle, N.S.W., Australia. His present post involves a leadership role in teaching and research, and also responsibility for administrative matters.

Grateful thanks are herewith expressed to him for his valuable contribution.

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LANGUAGE DEVELOPMENT AND INTELLECTUAL FUNCTIONING

by K.F. Collis

Introduction

It is becoming increasingly clear that the main purpose of schooling is to assist in the intellectual development of the individual. As Donaldson (1978) points out, intellectual skills are the most highly prized and most frequently rewarded of all. In addition, recent research into the development of intellectual functioning reinforces the crucial connection between language development and intellectual development. The purpose of this paper is to outline some recent work in the area of cognitive functioning, and to show how this highlights the necessity for great care to be taken in fostering a child's language competence at least at two different stages: one in very early childhood, and the other at early to middle primary school.

The development of intellectual functioning

From entirely different starting points, several groups of researchers in different parts of the world (Biggs and Collis, 1982; Marton, 1981; Case, 1980; Fischer, 1980) have devised very similar models for the development of intellectual functioning in children and young adults. It is proposed to take the one by Biggs and Collis and describe it in some detail.

Biggs and Collis began by setting themselves the task of giving teachers actual classroom examples of levels of cognitive development which teachers would recognize from their interactions with children in classroom situations. They had planned to do this across several curriculum areas such as mathematics, English, history, geography, economics and foreign languages, using examples obtained from previous research, from practising teachers, and from original surveys conducted in schools. Their analysis of the responses from these various sources made it clear that they were in fact dealing with two phenomena. The first was what they chose to call the Hypothetical Cognitive Structure (HCS), and the second the Structure Of the Learned Outcomes or Responses (SOLO).

The former was closely related to the existing notion of Piaget's stages of cognitive development¹ in which each stage has its

¹/ Sensori-motor (birth to 2 years); Intuitive/Pre-operational (2-6 years); Concrete Operational (7-15 years); Formal Operational (16+ years).

idiosyncratic mode of functioning and, as far as intellectual development is concerned, its own set of developmental tasks. The latter, on the other hand, was concerned with describing the structure of any given response as a phenomenon in its own right, that is, without the response necessarily representing a particular stage of intellectual development.

As was mentioned above, each of the major stages developed by Piaget has a typical mode of functioning and, in fact, is largely determined by the kind of elements that the individual can use and by the nature and complexity of the operations which he can apply to those elements. Examples of the nature of the elements and the kind of manipulations available at each of the stages are as follows:

1. Sensori-motor: the elements are the objects in the immediate physical environment, and the operations involve the management and co-ordination of motor responses in respect of these objects.
2. Intuitive/Pre-operational: the elements become signifiers (words, images, etc.) which stand for objects and events, and the operational side involves the manipulation of these in oral communication.
3. Concrete Operational: the elements develop from mere signifiers to concepts and operations which are manipulated using a logic of classes and equivalences, both elements and manipulations being directly related to the real world.
4. Formal operational: the elements are abstract concepts and propositions, and the operational aspect is concerned with determining actual and deduced relationships between them; neither the elements nor the operations need a real world referent.

The structure of the learned responses which occurs within each stage becomes increasingly complex as the cycle develops. Uni-structural responses represent the use of only one relevant aspect of the mode; multi-structural, several disjoint aspects, usually in a sequence; relational, several aspects related into an integrated whole; extended abstract takes the whole process into a new mode of functioning.

An illustration of this structure within a mode may be helpful. Let us select the concrete operational mode. A class has been given a lesson on the formation of rain, and the teacher asks the question:

"Why is the side of a mountain which faces the coast usually wetter than the other side?" The following responses may be obtained from students:

1. "Because it rains more on the coastal side."
2. "Because the sea breezes hit the coastal side first."
3. "Because the sea breezes contain water vapour and they first strike the coastal side, and so it rains on them, and after that there's no rain to fall on the other side."
4. "Because the prevailing winds are from the sea and they pick up moisture, and as they meet the mountain they're forced up and get colder, the moisture condenses, forming rain. By the time the winds cross the mountain, they are dry."
5. "This is likely to be true only if the prevailing winds are from the sea. When this is so, the water vapour evaporated from the sea is carried to the mountain slopes, where it rises and cools. Cooling causes the water vapour to condense and deposit. Not only is the wind now drier, it is then carried up the mountain further, is compressed, now warms, and thus is relatively less saturated than before. The effect is similar to the warm climates experienced on the eastern slopes of the Rockies in Canada in winter. However, all this makes assumptions about the prevailing wind and temperature conditions; if these were altered, then the energy exchanges would differ, resulting in quite a different outcome."

The five responses listed above represent both an increase in the use of the information available and an increase in the complexity with which it is put together. Let us look at the responses in terms of the learning cycle concept set out above.

Response 1 merely restates the question and fails to engage any relevant information from the previous lesson - thus it would be classified as pre-structural.

Response 2 gives an answer to the question but applies only one of a number of possible pieces of relevant information (or propositions) to the problem - thus it is classified as uni-structural.

Response 3 answers the question and uses several appropriate facts (or propositions) in sequence to justify the conclusion - hence, a multi-structural response.

Response 4 not only answers the question by using several facts (or propositions) but endeavours to integrate them. The introduction of an integrating principle makes this a relational response.

Response 5 shows an entirely new use of the available information (or propositions). Instead of immediately accepting the conclusion implicit in the question, the student points out that there are other possibilities and uses the given data to test out some of these hypotheses. This represents an extended abstract level of responding.

The above example applies to the concrete operational mode of functioning. To further clarify the concept, let us take another example this time from the sensori-motor mode, typical of children from birth to about 18-24 months of age. Further, let us consider the learning cycle in relation to the important concept of object permanence, in this case a typical plaything such as a ball.

Pre-structural: if the ball rolls out of sight, the infant does not look for it, but acts as though it no longer exists.

Uni-structural: the infant uses only one sense modality, usually sight, to look for the ball that has rolled away; if it is not immediately successful, the infant gives up.

Multi-structural: if the ball is placed under a cushion in full view of the child, he will retrieve the ball by raising the cushion. However, if, again in full view of the child, the ball is removed from under the original cushion and placed under a nearby cushion, the child continues to look under the original cushion. The child uses more than one sense modality, but does not co-ordinate the information.

Relational: the child solves the problem of sequential displacements, first when he sees the displacement, later even when the displacement is unseen.

Extended Abstract: in the absence of the ball, the child will ask for it, i.e., "ball?". This response represents a move to a new mode of functioning, and the cycle begins again with this response representing the uni-structural stage of the new cycle.

These notions are well summarized in Figure 1.

Figure 1
Response model of intellectual functioning

1. Mode (Developmental stage)	2. Response structure (Learning cycle)	3. Use of language
Sensori-motor (infancy)	<u>Uni-structural</u> <u>Multi-structural</u> <u>Relational</u> Extended abstract	
Intuitive/Pre- operational (early childhood - pre-school)	 <u>Uni-structural</u> <u>Multi-structural</u> <u>Relational</u> Extended abstract	Words
Concrete Operational (childhood to adolescence)	 <u>Uni-structural</u> <u>Multi-structural</u> <u>Relational</u> Extended abstract	Sentences
Formal - 1st Order early adult	 <u>Uni-structural</u> <u>Multi-structural</u> <u>Relational</u> Extended abstract	Propositions
Formal - 2nd Order and higher order adult	 <u>Uni-structural</u> <u>Multi-structural</u> etc.	Propositions of increasingly higher order of abstraction

Column 1 shows the stage of development or mode of functioning level and is closely related to the Piagetian model. Column 2 details the learning cycle as it occurs within each stage and from stage to stage. Column 3 illustrates the extended abstract level of achievement with respect to the development of language at the various developmental stages: single-word sentences being the achievement of the sensori-motor stage; sentences at a mature level of complexity for communication purposes the achievement of the next stage; and finally full propositional logic being the end result of the concrete operational stage.

The most obvious question which arises in relation to the development in each learning cycle is: how does it take place? To answer this question, we will turn to the work of Robbie Case who, building on the work of Pascual-Leone, has elaborated the information processing model in this area.

Case (1980) introduces the concept of automaticity. He regards the working memory^{1/} as having two components: one into which the variables to be worked on are taken and held, and the other, the working space, where these variables are actually operated upon. As the total space available in the working memory at any one time is constant, the more attention paid to the variables, the less the space available for working. For instance at the early pre-operational stage of functioning, a large amount of 'mind space' is occupied by the individual word that the child is only beginning to become familiar with; thus there is only limited space for working with the words. As words become more and more automated, they occupy less space, and consequently more space is available for operations on them. This culminates in the individual being able to repeat and use quite complex, extended sentences for the purpose of oral communication. Likewise, during the concrete operational phase, the cycle repeats itself, only this time the unit being automated is the sentence used as a proposition bearing upon the resolution of some problem.

Having reached a high level of functioning in oral communication, the child starts on a new developmental task: the achievement of formal logical reasoning using propositions. To begin this task, the child has to use sentences in a new way. Instead of merely being the means of oral communication, the child has now to use sentences as propositional statements upon which to base conclusions. The development of this function through the new learning cycle has been traced in the 'rain formation' example above and will not be repeated at this point.

^{1/} Working or Short-Term Memory is hypothesized as that part of the mind in which immediate conscious thought processing takes place.

Several new elements become important at the beginning of the concrete operational stage for the child to continue to progress. Unlike oral communication, reasoning with sentences requires that some form of record be available to secure what has been said in some tangible form; moreover, the increasing need to learn to manipulate abstractions leads to demands for handling abstract symbol systems - both of these aspects are catered for, at least in part, by the introduction of reading and writing. However, it is reasonably clear that a high level of oral communication skill is a pre-requisite for learning to read and write. This statement would appear to be true whether we look at the motivational aspects involved or the learning of the skills themselves, because the skills of reading and writing are not natural like walking or eating, and thus require a high degree of perseverance and practice on the part of the individual in order to attain them. Without strong motivation on the part of the child, in part engendered by success and interest in previous communication attempts, the necessary degree of dedication is unlikely to be forthcoming. The skills of reading and writing involve decoding and encoding (respectively) symbols which have meaning in the language with which the child communicates. If the general form and expectations of word groupings (for example) in the language are not highly developed, the child is placed in such a complex situation that it is unlikely that he will be able to cope.

Language development and logical functioning

Several points relevant to our thesis about the importance of language development to intellectual functioning should be clear from the above model. First, the model is hierarchical both within modes (stages) and between modes in the sense that higher-level performance subsumes performance at the lower levels, and is itself built upon satisfactory performance at these lower levels. Secondly, the mode of intellectual functioning is closely related to the kind of logic available to the individual which in its turn is dependent upon the level of abstraction of the elements of thinking and the ability to manipulate these elements with maximum efficiency. This last is closely related to the development of language which begins the process of abstraction when words begin to be used as signifiers for objects. For example, if we take the following sentence: "John likes to feed the little puppies in the barn by the meadow,"^{1/} and ask

^{1/} An adaptation of an item from the Stanford Binet intelligence test

children from about 1½ years to 6 years (pre-operational mode of functioning) to repeat it after us, we can see the learning cycle for oral communication unfolding. The cycle may go as follows:

1. Uni-structural: "Johnnie!" or "puppies!" "barn!"
One-word sentences selected from one part of the statement.
2. Multi-structural: "puppies in barn"; "John feed puppies".
Sentences of a few words; selecting a couple of the significant components of the original statement.
3. Relational: "John likes to feed the little puppies in the barn." Almost the whole sentence and arranged correctly.
4. Extended abstract: "John likes to feed the little puppies in the barn by the meadow." This represents a full grasp of the statement including its modifiers. Further investigation shows that this level of functioning is at the adult level as far as the use of language for oral communication is concerned. It is probably not too much to say that the achievement of this level of language has been the major developmental task for the child throughout the pre-operational stage so far as intellectual development is concerned.

Thus it is argued that intellectual development goes hand in hand with language development. Any deficit in one will be reflected in the other. From an educator's point of view, both the pre-school and the early to middle primary years are critical. If it is intended that the child begin to develop his system of propositional logic, upon which high-level intellectual functions appear to be based, then we must ensure that during the early primary years his oral language competence has reached a very high level as early as possible. This can only be done by giving the child sufficient practice with the elements of the system (words) and operations on them (putting words together for communication) to enable him to make this form of communication automatic. In other words, from infancy onwards the child needs to be encouraged to talk. The use of stories, certain games, nursery rhymes, and regular interchange with adults and older children as well as peers in this is obvious. Another reason for this being a critical stage is that the evidence suggests that it is a developmental task and, as such, is one readily engaged in by the age group. If this critical period is passed through without the necessary development taking place, it becomes much more difficult to achieve. Evidence of this phenomenon can be seen when illiterate adults are being taught to read. In general they find the task much more difficult than do children at early

primary school. It appears that, having bypassed the skill, the individual builds up compensatory strategies which enable him to cope with the concrete environment, but which interfere with the development of an alternative, but more abstract, mechanism. Needless to say high-level intellectual skills of the kind described in this paper are not usually available to the illiterate person.

The task then at the beginning of primary school must be to ensure a high level of oral communication that leads on to the use of sentences in the form of propositions. This latter development, which takes place during the early and middle primary school years, is crucial for an individual striving to reach the top level of intellectual functioning, and means that the sentence as a proposition must be automated so that the individual can discern an overriding general principle connecting the propositions as a prelude to setting up hypotheses and testing them. The role of reading and writing in this stage is clear. They are the further development of language skills which not only help the child work with abstractions, but also provide a tangible record of propositions available for use in reasoning. Again it appears that we are involved in a developmental task where the acquisition of the appropriate skills at this time is critical for future development.

In summary then, it seems that the achievement of competence with a highly developed language of communication is a developmental task with significant implications for the development of intellectual skills of a high order. That this latter development is highly prized in all cultures is undoubted, and thus it behoves educators in all countries to direct their attention to the ways and means of achieving it. On the basis of recent research, it appears that much more attention needs to be given than before to the development of oral communication skills in the pre-school years and to a basic re-consideration of the reasons for teaching reading and writing skills during the primary school years. Words become sentences which in turn become propositions - these latter are the stuff of high-level intellectual functioning.

APPENDIX I

An example of the Response Model (SOLO Taxonomy) in use:

The evaluation of the quality of creative writing

Creative writing in this context is a prose composition on a topic selected by the writer for the purpose of self-expression - an exercise common to most written language courses. Evaluating the quality of such an exercise can be made much more rational and consistent by applying the principles underlying the Response Model (SOLO Taxonomy) described in the main part of this paper.

In making a response to a creative writing task, the individual has a set of elements to work with - words - and a set of operations which can be performed on the elements - sentence and paragraph construction. Quality judgements can be made either separately or in combination for the elements and the operations. For example, one can consider the words themselves in terms of a number of criteria, among which might be the following:

1. Correctness of spelling;
2. Appropriateness of usage;
3. Level of abstraction represented.

One can also consider the structure of the sentences and paragraphs in terms of criteria such as story development, intelligibility, use of change of length or construction. For judgements on high-level writing, one has to take into account what amounts to an interplay between the elements and operations such as would be represented by the use of metaphor, sense of audience, overlay of meaning.

When examples of creative writing are examined, it is found that they can be readily classified according to the structure of response or learning cycle concept. The distinguishing features of the five levels within the concrete operational mode for this task are set out below.

Pre-structural: writing at this level is best described as incoherent. There is no consistent component - the words, very often incorrectly spelt, appear as they occur to the writer and generally make little sense to a reader.

Uni-structural: one component is utilized to bring some order to the story - usually this is sequencing in time. The writing is simplistic and, because of its adherence to a time line, may be described as linear.

Multi-structural: the writer shows mastery of certain basic components such as spelling, punctuation, syntax and the ability to tell a story, but the components are seen independently and are not integrated for effect. The writing may be described as conventional because, although the basic techniques of written communication are available, the result is flat and unimaginative. Daily newspapers and the pulp magazines generally display this level of writing skill.

Relational: This level of response shows an integration of the basic components which allows for flexible combinations which are deployed for effect. The writer takes into account the prospective reader and orchestrates the elements and operations to affect the feelings, thoughts, etc., of the reader. The major limitation of this response lies in the fact that it is bound by the particular context which the writer has selected - it has no overlay of meaning - similes are used, but not metaphors.

Extended abstract: Responses at this level add two features to the previous level: overlay of meaning and innovative use of the medium. The former ensures that the response has layers of meaning beyond the particular context - the writing is metaphorical in this sense. The latter involves the imaginative use of techniques to convey multiple meanings.

Biggs and Collis (op.cit.) have collected and analysed many samples of responses given by children and adolescents in this area. To fill out the descriptions of the levels given above, a selection of examples follow. ^{1/}

^{1/} The following examples are taken from: Biggs, J.B. and collis, K.F. Evaluating the Quality of Learning: The SOLO Taxonomy, Academic Press Inc., N.Y., 1982

Pre-structural

A Boating Holiday

"I was at the port and saw a raft with some kinds in it Dinki a captain in a tugboat Oceanliner with the crew waving a submarine surfising to the top a cook in a house boat and many many more in the ocean it was favulos and went home to tell the news I did at the port on Sunday." (page 111)

The writer has an overall image of the port in mind and sets down events as they occur to him. The result lacks coherence and does not communicate even the basic facts very well.

Uni-structural

A Boating Holiday

"We boarded the ship at 2 p.m. We leved about 9 o'clock everyone was sitting on the deck it was a nice night the starts were out. In the morning we played tabletenners we all swam we stop at the first port which was singapore we stayed there for 3 days all the time we were there all we seme was by things eat. When we were liveing we got a big band playing on the port." (page 112)

The basic facts are set out using sequencing in time as the device to make the story coherent. The events described are based on the writer's concrete experiences with little regard to a prospective reader's likely questions or interest.

Multi-structural

What to Do on a Really Hot Day

"On a really hot day I would like to relax and go swimming, and sunbathing.

As I rolled over in my bed covers the bright sunlight struck my eyes. What a beautiful day I thought to myself as I slowly got out of bed. Today I would gather up some friends and head down to the wild surf and sandy beach.

When we arrived there the golden sand shone brightly expanding around the circular bay. We took our bags, beachtowels and radio and made our way through the sand to a little opening where the sun was about us, and also shade from a nearby tree. We put our towels down turned on the radio as we began to sunbake " (page 114)

The writer not only gives information but reveals her personal feelings. The writer shows a competent use of several components, but does not have sufficient mastery to overcome the flat, conventional effect. The use of stereotypical descriptions (bright sunlight, sandy beach, etc.) is typical of this level of response.

Relational

Country School

"The young girl came bouncing round the corner chirping and bright. Her hair sun bright shining, teeth of an aborigine dressed in the prettiest grass green dress.

She boards the bus greeted by a snarling busdriver, who obviously had a late night and getting up with the birds, would not help matters.

She's one for telling tales as big as mountains, and her friends listen carefully with fly-catching mouths.

The bus jerks and their on their way to school. The weather ice cold invites the fog to settle on the bus window while the children engrave their initials.

The endless lucious grass is stretched as wide as the ocean, but soon the school house is in sight, a blob in the not so far distance.

Now they're all settled in class with teacher out front discussing the road to success to her basset hound pupils looking very vague. Her superiority is displayed in the way she lets her pupils know whose boss!" (page 116)

The essence of this level is integration which allows for the description of the feelings of others and the adoption of alternative points of view. This writer keeps all the components in balance and makes clear the point that she wishes to come through. Note also how she seeks to bring in the motives and feelings of others.

Extended abstract

Signs of Spring

"It was in the spaces of a thick green bush that was kissed by the vibrant rays of the sun. In the clearing a young couple sat beside a blue glassy stream, that laughed and bubbled over the mossy pebbles.

The young man, thin and tanned, smiled warmly and picked a small flower and placed it in the girl's long brown hair. She laughed contentedly - but neither spoke a word. I looked deep at their relationship - and the disasters of the world flashed past me in one quick second. Then suddenly I realized, all the money in the world, all the wars, battles and strife could not affect or change someone as much as love.

The couple still sat silently - but their silence was deafening. It screamed out to the world - scratched, tore and pounded at all the hearts that would listen. Listen?

Have you ever heard love, have you ever stopped to listen? How many of you have ever sat silently like this couple and listened to the love that surrounds you? Maybe some of you, or maybe you just can't hear, because you live in your world of pollution, over population and drugs.

Look deep - do you see the couple in the clearing? They are richer and happier than all of you. They are uninhibited and touched by love.

I walked away slowly, looking at the fresh flowers, listening to the young birds. It was Spring, I could tell. It wrapped itself around me and showed me love - nothing is more beautiful than the signs of Spring." (pages 120-121)

The two additional features pertaining to this level of response are clearly illustrated in this example. The overlay of meaning is demonstrated by the use of the young couple in the clearing as a vehicle to introduce the notions of love and spring, while the innovative use of the medium is seen in the use of the formal properties of writing (sentence structure, length, punctuation) in conjunction with vivid imagery and a simple story to create and change moods.

References

Relevant abstracts or summaries relating to these references may be found in Annexes 1-5.

- Biggs, J.B. and Collis, K.F. Evaluating the quality of learning: the SOLO Taxonomy. Academic Press Inc., N.Y., 1982 (See Annex 1)
- Case, Robbie "The underlying mechanism of intellectual development" in Cognition, development and instruction (Eds. Kirby, J.R. and Biggs, J.B.) Academic Press Inc., N.Y., 1980 (See Annex 2)
- Donaldson, Margaret Children's minds. Fontana/Collins, Glasgow, 1978 (See Annex 3)
- Fischer, Kurt W. "A theory of cognitive development: the control and construction of hierarchies of skills", Psychological review, 1980, Vol. 87, No. 6, 477-531 (See Annex 4)
- Marton, Ference "Phenomenography - describing conceptions of the world around us", Instructional science, 1981, Vol. 10, 177-200 (See Annex 5)

ANNEX 1

Evaluating the quality of learning: the SOLO Taxonomy
by J.B. Biggs (University of Newcastle, Australia) and
K.F. Collis (University of Tasmania, Australia)

(An abstract from the promotional pamphlet on the text)

This book outlines clearly and in non-specialist language the SOLO Taxonomy, a model of the objective and systematic assessment of the quality of learning. The authors studied the organization of responses from hundreds of students at the elementary through college levels in such subjects as history, mathematics, creative writing, reading, geography, and foreign languages, and found that a similar structure emerged in all cases. This Structure of the Observed Learning Outcome forms the basis of the SOLO Taxonomy, which may be applied to evaluate learning in a wide variety of school and college situations in most subject areas.

Unlike the Bloom Taxonomy, used mostly for set questions and items, the SOLO Taxonomy is designed to evaluate open-ended responses to existing questions, problems, and item types. The Taxonomy is based on the assumption that structural organization gives an important clue as to the quality of learning in much the same way as it was used by Piaget and others to distinguish mature from immature thought. The book distinguishes five levels of structure, with four transitional stages between each. Although the book focuses on evaluating learning at the junior and senior school levels, the model is applicable to evaluation at the elementary and college levels as well.

Parts I through III are quite general and written for the non-specialist. Part I describes the general nature of the Taxonomy. The first chapter in this section discusses the nature of instruction and the evaluation of learning, outlining a model of instruction that provides a useful framework for the rest of the book. The next chapter explains the link between the developmental stage and learning quality, and concludes with a description of the Taxonomy itself. Part II applies the Taxonomy to particular subject areas, using example ranging from elementary through senior high school levels. Teachers who specialize in one or more of these teaching subjects will be particularly interested in this section.

Part III addresses the general implications that the SOLO Taxonomy has for educational practice, and explores its use in curriculum design and instruction, as well as in evaluation. Part IV raises issues of a more technical nature that will be of special interest to psychologists. This section examines such issues as item reliability and validity and research findings that shed light on the psychological processes involved in transitions across the SOLO levels. It also proposes a general model of learning that links cyclical growth in the complexity of learning to the stages of cognitive development outlined in neo-Piagetian theory. The model has wide generality, and applications to motor skill learning, perceptual discrimination, decision-making, and communication skills are discussed.

ANNEX 2

The underlying mechanism of intellectual development by Robbie Case (University of Toronto, Canada)

(An adaptation of the summary from the chapter concerned)

According to Piaget, intellectual development may be divided into four general periods or stages: the sensori-motor stage (0-2 years), the pre-operational stage (2-6 years), the concrete operational stage (6-12 years), and the formal operational stage (11-16 years). In this chapter, Case provides an account of intellectual development that is broadly consistent with Piaget's, but which accounts for the changes that are observed at a more detailed level of analysis. In constructing this account, he draws on three basic ideas which have been proposed by others. The first is that the operational structures of each Piagetian stage can be modelled as sets of executive strategies. The second is that the acquisition and application of any given executive strategy requires a working memory of specifiable size. The third is that the greater a child's familiarity with an intellectual operation, the less attention this operation requires for execution.

In summary, the basic postulates of the new theory are as follows:

1. Within each stage of development, children develop intellectual strategies for coping with the tasks which are characteristic of that stage.
2. In response to experience in using their first primitive strategies in a stage, children revise these strategies and incorporate more complex routines into them.
3. Since more complex routines take account of more information, children need more than simple experience in order to acquire information. The maximum number of items a child can co-ordinate at any one moment is referred to as his or her working memory.
4. Within each stage, working memory for the type of task which is characteristic of that stage develops very slowly, in response either to maturation or massive practice in executing the basic mental operations of the stage.
5. The basic mental operations which are used in the strategies of one stage are assembled in working memory from components which are developed in the previous stage. As a result, a certain size working memory at one stage is a pre-requisite for entry into the next.

The basic corollaries of the theory are as follows:

1. Operational difficulty, because it affects functional working memory, can be responsible for producing a *décalage* in the age of strategy emergence across different domains.
2. The critical size working memory below which no effective strategy can be assembled is two, since only then can a genuine relationship between two items be perceived and acted upon.

ANNEX 3

Children's minds

by Margaret Donaldson (University of Edinburgh, U.K.)

(A shortened version of the summary of the text appearing on the back cover of the original book)

Why do so many children find school learning difficult? Why does the lively pre-school child so often become a semi-literate and defeated 'school failure'? What goes wrong?

These questions are answered in this book with dramatic new evidence. Drawing on the latest research, Margaret Donaldson shows that much of the intellectual framework on which we have tended to base our teaching is misleading. She argues that we have both underestimated the astonishing rational powers of young children (largely because of the influence of Piaget's theories), and at the same time have ignored the major stumbling block that children face when starting school.

Research shows that, given a setting and a language that make sense to them in human terms, very young children can perform tasks often thought to be beyond them. The pre-school child learns everything in a human situation. Only when school starts is he asked to acquire skills, such as reading, writing and arithmetic, isolated from a 'real-life' context. The transition is difficult, but it is one that all our children have to try to make, sooner in a formal school, later but inevitably in an informal one.

Margaret Donaldson suggests a range of strategies schools could adopt to help children. She argues that the teaching of reading is even more important than we have thought it to be, since learning to read can actually speed children through the crucial transition.

ANNEX 4

A theory of cognitive development: the control and construction of hierarchies of skills

by Kurt W. Fischer (University of Denver, U.S.A.)

(An abstract from the original journal article)

A theory of cognitive development, called skill theory, attempts to provide tools for the prediction of developmental sequences and synchronies in any domain at any point in development by integrating behavioural and cognitive-developmental concepts. Cognitive development is explained by a series of skill structures called levels together with a set of transformation rules that relate these levels to each other. The levels designate skills of gradually increasing complexity, with a specific skill at one level built directly from specific skills at the preceding level. The transformation rules specify the particular developmental steps by which a skill moves gradually from one level to the next. At every step in these developmental sequences, the individual controls a particular skill; that is, he or she controls a structure composed of one or more sources of variation in what he or she does or thinks in a specific context. In development, these skills are gradually transformed from sensory-motor actions to representations and then to abstractions. The transformations produce continuous and gradual behavioural changes; but across the entire profile of a person's skills and within highly practised task domains, a stage-like shift in skills occurs as the person develops to a new optimal level. The theory suggests a common framework for integrating developmental analyses of cognitive skills, social skills, language, and perceptual-motor skills, as well as certain behavioural changes in learning and problem solving.

Phenomenography - Describing conceptions of the world around us
by Ference Marton (University of Göteborg, Sweden)

(An abstract from the original journal article)

Arguments are put forward in this paper in favour of research which has as its aim the finding and systematizing of forms of thought in terms of which people interpret significant aspects of reality. The kind of research argued for is complementary to other kinds of research. It aims at description, analysis and understanding of experiences. The relatively distinct field of inquiry indicated by such an orientation is labelled phenomenography.

A fundamental distinction is made between two perspectives. From the first-order perspective we aim at describing various aspects of the world, and from the second-order perspective (for which a case is made in this paper) we aim at describing people's experience of various aspects of the world.

Research in a variety of disciplines, sub-disciplines and 'schools of thought' has provided us with experiential descriptions, that is, content-oriented and interpretative descriptions of the qualitatively different ways in which people perceive and understand their reality. It has, however, seldom been recognized that these various research efforts share a common perspective in their view of phenomena, and a unifying scientific identity has in consequence not been attained. The focusing on the apprehended (experienced, conceptualized,) content as a point of departure for carrying out research and as a basis for integrating the findings is seen as the most distinctive feature of the domain indicated.

Conceptions and ways of understanding are not seen as individual qualities. Conceptions of reality are considered rather as categories of description to be used in facilitating the grasp of concrete cases of human functioning. Since the same categories of description appear in different situations, the set of categories is thus stable and generalizable between the situations even if individuals move from one category to another on different occasions. The totality of such categories of description denotes a kind of collective intellect, an evolutionary tool in continual development.

The Asian Programme of Educational Innovation for Development (APEID) has as its primary goal to contribute to the building of national capabilities for undertaking educational innovations linked to the problems of national development, thereby improving the quality of life of the people in the Member States.

All projects and activities within the framework of APEID are designed, developed and implemented co-operatively by the participating Member States through over one hundred national centres which they have associated for this purpose with APEID.

The 21 countries in Asia and the Pacific participating in APEID are: Afghanistan, Australia, Bangladesh, China, India, Indonesia, Iran, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Nepal, New Zealand, Pakistan, Papua New Guinea, Philippines, Republic of Korea, Singapore, Socialist Republic of Viet Nam, Sri Lanka and Thailand.

Each country has set up a National Development Group (NDG) to identify and support educational innovations for development within the country and facilitate exchange between countries.

The Asian Centre of Educational Innovation for Development (ACEID), an integral part of the Unesco Regional Office for Education in Asia and the Pacific in Bangkok, co-ordinates the activities under APEID and assists the Associated Centres (AC) in carrying them out.

The eight programme areas under which the APEID activities are organized during the third cycle (1982-1986) are:

1. Universalization of education: access to education at first level by both formal and non-formal means;
2. Education for promotion of scientific and technological competence and creativity;
3. Education and work;
4. Education and rural development;
5. Education and urban development;
6. Educational technology with stress on mass media and low-cost instructional materials;
7. Professional support services and training of educational personnel;
8. Co-operative studies, reflections and research related to educational development and future orientations.